

INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) AND STUDENTS' ACADEMIC PERFORMANCE IN MATHEMATICS IN SENIOR SECONDARY SCHOOLS IN SAGBAMA LOCAL GOVERNMENT AREA OF BAYELSA STATE, NIGERIA

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Abstract

The study examined the relationship between Information and Communication Technology (ICT) and students' academic performance in mathematics in senior secondary schools in Sagbama Local Government Area of Bayelsa State, Nigeria. A correlational survey design was adopted, guided by two research questions and two hypotheses. The population comprised 3,400 senior secondary school 2 (SS2) students across all public secondary schools in the area. A sample of 393 students was selected using a simple random sampling technique. Data collection was executed using two instruments: a self-designed structured ICT Integration Questionnaire (IIQ) and a Mathematics Achievement Test (MAT), which demonstrated a high reliability coefficient of 0.84 via the test-retest method. Data were analyzed using the Pearson Product Moment Correlation coefficient at the 0.05 level of significance. The findings revealed a low negative, non-significant relationship between the availability of digital learning tools and students' academic performance in mathematics. The study further revealed a moderate positive but non-significant relationship between the utilization of interactive presentation systems and students' academic performance in mathematics. The study concluded that ICT facilities alone may not significantly influence mathematics achievement without effective implementation, teacher competence, and supportive infrastructural conditions. It was recommended that educational stakeholders should strengthen teacher ICT capacity, improve supporting infrastructure, and ensure the effective utilization and maintenance of digital instructional resources in secondary schools.

Keywords: Information and Communication Technology (ICT), Mathematics, Academic performance, and Senior secondary schools.

Introduction

Education serves as a primary vehicle for national growth, societal transformation, and individual empowerment. Historically, the evolution of formal education delivery across developing nations reflects a continuous push to create structured environments capable of meeting expanding learner populations through modern instructional methodologies (Comb, 2019). Within the Nigerian landscape, the pursuit of foundational education models has long highlighted the vital role played by physical infrastructure and technological support systems in driving national literacy and human capital development (Fafunwa, 1974). In modern academic configurations, the capacity of an institution to fulfill its instructional mandates

hinges extensively on the composition, adequacy, and operational standards of its technological framework.

The integration of Information and Communication Technology (ICT) utilities constitutes the modern framework of educational institutions, encompassing digital devices, specialized applications, and network infrastructure that collectively drive instructional delivery. According to Onurgbo and Onurgbo (2023), ICT integration encompasses the entire spatial and technological architecture of an educational establishment ranging from computing hardware and software packages to internet connectivity and interactive whiteboards. When these digital elements are

progressively expanded and well-maintained, they create an optimal baseline that directly handles the escalating societal demands for quality secondary education in an increasingly digital world (Balderstens, 2021). Within this instructional infrastructure, specialized computing resources, such as mathematics software, play a vital role in transforming abstract ideas into visible, interactive realities (Salau, 2021).

Mathematics stands as a foundational pillar of modern science, technological innovation, and economic development (Smith, 2020). Its principles underpin logical reasoning, analytical problem-solving, and critical thinking skills required for survival in an increasingly quantitative world (Jones, 2018). In the Nigerian educational framework, mathematics is a compulsory subject across primary and secondary levels, serving as a core prerequisite for higher education placement and career progression in science, technology, engineering, and mathematics (STEM) tracks (Emenato, 2022). Despite its undisputed value, student achievement in mathematics at the secondary school level has remained a persistent challenge, often characterized by low retention, high test anxiety, and sub-optimal performance in external certificate examinations (Okeke, 2015).

This trend of poor academic achievement is deeply linked to the technological quality of the learning environment. The physical and digital conditions under which instruction occurs heavily shape the cognitive engagement and behavioral adjustment of learners. Among these conditions, digital learning tools serve as a fundamental technological component that dictates conceptual engagement during instructional periods. Digital learning tools include computing hardware, mathematics software packages (such as GeoGebra), math applications, and graphics tablets used by teachers and students. The availability and student-side manipulation of digital technologies significantly determine student attention spans, conceptual clarity, and overall problem-solving speed during academic tasks. When students are deprived of functional computing tools, learning

defaults to passive recitation, which increases abstract cognitive overload and degrades performance in demanding subjects (Nain, 2019). Conversely, a highly functional digital infrastructure layout fosters an interactive classroom atmosphere conducive to sustained academic behavior (L. Smith, 2015).

Beyond individual computing devices, the actual translation of pedagogical concepts across a large classroom requires the active deployment of interactive presentation systems. Interactive presentation systems refer to an array of audiovisual teaching technologies, including digital projectors, interactive smartboards, multimedia setups, and document cameras utilized by educators to present complex visual figures. As noted by Fadeiye (2018), these interactive systems bridge the gap between static textbook text and active, multi-sensory visual representation, turning passive classrooms into active spaces of co-discovery. The systematic utilization of varied presentation technologies is indispensable in sustaining learner attention, motivating curiosity, and maintaining high engagement levels across diverse student groups (Agosibe, 2017). When schools suffer from a chronic shortage or total absence of these modern display resources, teachers are forced to rely heavily on standard chalkboard lecturing methods, which limits long-term concept retention and reduces student interest (Oyarole & Adeola, 2017).

The successful mobilization and management of these critical ICT facilities depend on the combined investments of schools, families, and administrative authorities. Resource mobilization operates within a broader framework of community-institutional dynamics.

When these collaborative structures are effective, schools acquire the administrative capacity to deploy modern technology networks and systematically upgrade internal resource pools, which directly enhances institutional efficiency and school productivity (Adeyemi & Adu, 2010). However, when administrative frameworks fail to provide adequate

technological learning facilities, overall school performance declines, emphasizing the deep connection between material/digital inputs and educational outcomes (Akinsolu, 2010). Similarly, Owoeye and Yara (2011) observed that secondary schools equipped with high-quality institutional facilities consistently outperform poorly equipped schools in standardized examinations, highlighting infrastructure as a key predictor of student achievement.

In Sagbama Local Government Area of Bayelsa State, these technological challenges are often worsened by unique environmental and socioeconomic factors. Many public secondary schools in this region contend with a complete lack of computer hardware, unstable electricity grids, and an total absence of modern interactive display tools. While teachers strive to deliver standard curriculum content, the technological limitations of their instructional environments present severe operational barriers. Although general educational studies have explored school quality across Nigeria, there remains a critical research gap regarding how localized deficiencies in digital learning tools and specific interactive presentation systems uniquely correlate with mathematics performance within the public secondary schools of Sagbama Local Government Area. This study was explicitly designed to address this empirical gap.

Statement of the Problem

The persistent under performance of senior secondary school students in mathematics within Sagbama Local Government Area has become a matter of serious concern for parents, educators, and policymakers. Despite various manual curriculum interventions aimed at improving instructional delivery, student performance in internal assessments and external examinations like WAEC and NECO remains sub-optimal. This academic deficit is often blamed entirely on student work ethics, while ignoring the archaic technological conditions of the learning environment.

Preliminary observations across public secondary schools in Sagbama reveal a severe digital divide. The vast majority of classrooms

completely lack modern instructional technologies. Standard digital learning tools such as basic computing hardware and mathematics applications are non-existent, forcing instructors to teach abstract geometric transformations and complex statistical distributions using verbal descriptions and flat drawings on worn blackboards.

While educational literature establishes a general link between technology exposure and student outcomes, there is an empirical silence on how the intersection of digital tool scarcity and a lack of interactive multimedia presentations specifically correlates with mathematics achievement within this unique ecological and riverine zone of Bayelsa State. This study addresses this problem by answering the question: what is the relationship between Information and Communication Technology (ICT) infrastructure (digital learning tools and interactive presentation systems) and senior secondary school students' academic performance in mathematics in Sagbama Local Government Area?

Objective of the Study

The objective of this study is to examine the relationship between information and communication technology (ICT) and students' academic performance in mathematics in senior secondary schools in Sagbama Local Government Area of Bayelsa State, Nigeria. Specifically, the study seeks to:

1. Ascertain the relationship between the availability of digital learning tools and students' academic performance in mathematics in senior secondary schools in Sagbama Local Government Area of Bayelsa State.
2. Determine the relationship between the utilization of interactive presentation systems and students' academic performance in mathematics in senior secondary schools in Sagbama Local Government Area of Bayelsa State.

Research Questions

1. What is the relationship between the availability of digital learning tools and

students' academic performance in mathematics in senior secondary schools in Sagbama Local Government Area of Bayelsa State?

2. What is the relationship between the utilization of interactive presentation systems and students' academic performance in mathematics in senior secondary schools in Sagbama Local Government Area of Bayelsa State?

Hypotheses

1. There is no significant relationship between the availability of digital learning tools and students' academic performance in mathematics in senior secondary schools in Sagbama Local Government Area of Bayelsa State.
2. There is no significant relationship between the utilization of interactive presentation systems and students' academic performance in mathematics in senior secondary schools in Sagbama Local Government Area of Bayelsa State.

Review of Related Literature

Digital Learning Tools

Digital learning tools represent the primary material and operational interface between the student and modern educational technology. It comprises the essential technological components including desktop computers, tablets, specialized mathematics software (such as GeoGebra, SPSS, and graphing calculators), and digital math applications that facilitate active learning tasks. Digital learning tools go beyond basic computation; they function as cognitive technologies that expand human working memory and allow students to test mathematical hypotheses in real time. Proper access to these tools provides cognitive stabilization, which minimizes abstract confusion and allows students to maintain focus during long periods of problem-solving.

The adequacy and quality of digital learning tools shape the overall classroom climate. When computing devices are pre-loaded with interactive mathematics software, they create a welcoming environment that reduces math

phobia and off-task behaviors (Smith, 2015). Conversely, an environment devoid of modern computing infrastructure creates an abstract, alienating space that directly interferes with student attention. Nain (2019) notes that traditional, dry textbook delivery methods cause cognitive fatigue and frequent distractions. In secondary schools where mathematics lessons require multi-step algebraic procedures, graph plotting, and geometric analysis, the availability of responsive digital software tools is a vital requirement for effective modern learning.

Interactive Presentation Systems

Interactive presentation systems comprise the full range of multimedia display technologies used by educators to enrich, clarify, and accelerate the instructional process. These resources include digital video projectors, interactive smartboards, multimedia casting displays, and integrated audio systems. As emphasized by Fadeiye (2018), interactive presentation systems are not optional decorations; they are core pedagogical inputs that translate abstract curriculum concepts into dynamic visual models. They actively engage multiple senses, allowing students to see color-coded transformations, rotational geometry, and real-time statistical graph adjustments.

The pedagogical value of interactive presentation systems lies in their ability to stimulate and maintain learner motivation. Interactive media projection helps sustain student attention by introducing variety and practical visualization into classroom sessions (Agosibe, 2017). To Ibeneme (2018) interactive presentation displays also help accommodate individual learning differences within a large classroom, allowing visual and spatial learners to keep pace with verbal explanations. In mathematics education, where concepts like trigonometry, calculus, and vector spaces are naturally abstract, interactive presentation displays provide the structural scaffolding students need to ground these operations in clear visual realities.

Students' Academic Performance in Mathematics

Academic performance represents the observable, measurable outcome of a student's instructional experience within an educational system, typically quantified through standardized assessments, class tests, and external examinations. In secondary schools, mathematics performance serves as a key measure of an institution's instructional quality and a student's technical capability (Emenato, 2022). High academic achievement in mathematics reflects a student's mastery of computational techniques, logical reasoning, and quantitative problem-solving skills.

However, achieving high academic performance in mathematics is a complex process shaped by a mix of environmental, material, and technological inputs. Achievement in this subject is deeply influenced by the structural quality of the school environment and the availability of specialized teaching technology (Okeke, 2015). When students are placed in technologically optimized, well-equipped classrooms, their capacity to retain mathematical concepts increases, leading to better outcomes in terminal examinations. Thus, academic performance is not just a measure of student intelligence; it is an integrated reflection of the quality of the technological learning environment.

Theoretical Review

Cognitive Constructivist and Multimedia Learning Theory (Piaget & Vygotsky, 1978)

This study is anchored on the Constructivist paradigm established by Jean Piaget and Lev Vygotsky, which posits that learners actively construct their own knowledge rather than passively receiving information from instructors. Within a mathematics classroom, cognitive progression moves from concrete operational stages to formal abstract reasoning.

Constructivism argues that learning is deeply tied to the physical and interactive tools available within that space. In this study, digital learning tools (such as mathematical software applications and interactive graphing programs) serve as the cognitive scaffolding inputs required for dynamic learning. Without these digital tools, students cannot engage in the virtual

manipulation needed to internalize abstract mathematical variables. Consequently, a learning environment lacking ICT facilities restricts cognitive development, forcing students into rote memorization rather than true conceptual understanding.

Theory of Overlapping Spheres of Influence (Epstein, 1995)

This study also draws support from Joyce Epstein's Theory of Overlapping Spheres of Influence, which asserts that the education and socialization of children are collaborative responsibilities shared across three major institutional forces: the school, the family, and the wider community.

Epstein argues that student learning and development are optimized when these three spheres collaborate through systematic partnerships. In the context of this study, the provision, management, and maintenance of essential ICT infrastructure-such as computer hardware, stable alternative power supplies, and presentation systems-cannot be left solely to school administrators. It requires sustained financial, logistical, and structural investments from families, community associations (such as Parent-Teacher Associations), corporate organizations, and government authorities. When these spheres overlap productively, schools secure the necessary technological infrastructure, creating an organized, resource-rich physical environment that directly fosters student engagement and high academic achievement.

Empirical Review

Salau (2021) conducted a study investigating the impact of information and communication technology on the transformation of mathematics education across secondary schools in the regional clusters of Oyo State. The study adopted a survey design with a sample of 280 respondents. Data were gathered through a structured questionnaire and analyzed using descriptive and inferential statistics. The findings revealed that the regular availability of computing systems and mathematical learning applications significantly influenced the

conceptual retention and analytical speed of the learners. The study concluded that digital learning tools reduce classroom distractions and improve learning readiness.

While Salau (2021) established a significant link between technology availability and academic outcomes among students using a general survey design, the current study focuses specifically on senior secondary school 2 (SS2) students. It examines how digital tool availability correlates with performance in mathematics within the distinct geographical and administrative framework of Sagbama Local Government Area, Bayelsa State.

Onurgbo and Onurgbo (2023) examined the importance of ICT in teaching and learning across public secondary schools in the Gashua Educational Zone of Yobe State. The study employed a quasi-experimental research design involving a sample population of 180 junior secondary students. The experimental group was taught using a digital projector and interactive slide media, while the control group was taught via conventional blackboard lecturing methods. The collected data were analyzed using independent t-tests. The results demonstrated that students exposed to interactive presentation media achieved significantly higher post-test scores than those in the conventional group, concluding that multimedia display systems are critical for conceptual retention.

Although Onurgbo and Onurgbo (2023) confirmed the pedagogical benefits of interactive presentation systems, that study was restricted to a quasi-experimental framework for general courses within Yobe State. The current investigation extends this line of research by using a correlational survey design to analyze how the systematic utilization of interactive presentation systems relates to secondary school mathematics performance within the unique environmental and socioeconomic conditions of Bayelsa State.

Despite these insights, prior research has largely overlooked how localized shortages of digital tools and interactive presentation devices

intersect to influence senior secondary mathematics performance within the Niger Delta region, particularly in Sagbama Local Government Area. This study addresses this gap by conducting a focused correlational analysis within this specific educational environment.

Methodology

The study adopted a correlational survey design (Fleetwood, 2024). This design is highly appropriate because it allows the researcher to scientifically measure, analyze, and describe the strength and direction of the relationship between the independent variables (digital learning tools and interactive presentation systems) and the dependent variable (academic performance in mathematics) without manipulating the operational school environment. The target population comprised all 3,400 Senior Secondary School 2 (SS2) students currently registered across the public secondary schools operating within Sagbama Local Government Area. The SS2 cohort was selected because they had completed a full year of senior secondary mathematics instruction and were not yet under the immediate administrative restrictions of final external certificate registration.. Simple random sampling technique was used to draw a sample size of 393 senior secondary school 2 (SS2) students from the population. The instrument for data collection was a self-designed questionnaire titled: "ICT Integration Questionnaire (IIQ) and Mathematics Achievement Test (MAT)". Face and content validity were used in this study.

Experts in measurement and evaluation examined the items on the instrument and confirmed that they were adequate and suitable for the study. To determine the reliability of the instrument, a test-retest method was employed, the data obtained were analyzed using the Pearson Product Moment Correlation, which yielded a reliability coefficient of 0.84, indicating that the instrument was reliable for the study. Data used in this study were collected through the administration of the questionnaire to the selected sample. Pearson Product Moment Correlation was used to answer the research questions and test the hypotheses at 0.05 level of

significance.

State?

Results

Research Question One: What is the relationship between the availability of digital learning tools and students' academic performance in mathematics in senior secondary schools in Sagbama Local Government Area of Bayelsa

Hypothesis One: There is no significant relationship between the availability of digital learning tools and students' academic performance in mathematics in senior secondary schools in Sagbama Local Government Area of Bayelsa State.

Table 1: Pearson Product Correlation Coefficient Table Showing the Relationship Between Availability of Digital Learning Tools and Students' Academic Performance in Mathematics in Senior Secondary Schools in Sagbama Local Government Area of Bayelsa State

		Digital Learning Tools	Academic Performance
Digital Learning Tools	Pearson product moment Correlation	1	-0.212**
	Significant 2-tailed		0.201
	N	393	393
Academic Performance	Pearson Correlation	-0.212**	1
	Sig. (2-tailed)	0.201	
	N	393	393

** Correlation is significant at the 0.05 level (2-tailed).

Table 1 presents the Pearson Product Moment Correlation analysis showing the relationship between the availability of digital learning tools and students' academic performance in mathematics in senior secondary schools in Sagbama Local Government Area of Bayelsa State. The result yielded a correlation coefficient of $r = -0.212$, indicating a **low negative relationship** between the availability of digital learning tools and students' academic performance in mathematics. The corresponding probability value ($p = 0.201$) is greater than the established alpha level of 0.05 ($0.201 > 0.05$). Therefore, the null hypothesis is **accepted**. This implies that there is no statistically significant relationship between the availability of digital learning tools and students' academic

performance in mathematics in senior secondary schools in Sagbama Local Government Area of Bayelsa State.

Research Question Two: What is the relationship between the utilization of interactive presentation systems and students' academic performance in mathematics in senior secondary schools in Sagbama Local Government Area of Bayelsa State?

Hypothesis Two: There is no significant relationship between the utilization of interactive presentation systems and students' academic performance in mathematics in senior secondary schools in Sagbama Local Government Area of Bayelsa State.

Table 2: Pearson Product Correlation Coefficient Table Showing the Relationship Between the Utilization of Interactive Presentation Systems And Students' Academic Performance in Mathematics in Senior Secondary Schools in Sagbama Local Government Area of Bayelsa State

		Interactive Presentation Systems	Academic Performance
Interactive Presentation Systems	Pearson product	1	0.465**
	moment Correlation		
	Significant 2-tailed		0.164
	N	393	393
Academic Performance	Pearson Correlation	0.465**	1
	Sig. (2-tailed)	0.164	
	N	393	393

** Correlation is significant at the 0.05 level (2-tailed).

Table 2 presents the Pearson Product Moment Correlation analysis showing the relationship between the utilization of interactive presentation systems and students' academic performance in mathematics in senior secondary schools in Sagbama Local Government Area of Bayelsa State. The result produced a correlation coefficient of $r = 0.465$, indicating a **moderate positive relationship** between the utilization of interactive presentation systems and students' academic performance in mathematics. However, the associated probability value ($p = 0.164$) exceeds the 0.05 significance level ($0.164 > 0.05$). Therefore, the null hypothesis is **accepted**. This indicates that there is **no statistically significant relationship** between the utilization of interactive presentation systems and students' academic performance in mathematics among senior secondary school students in Sagbama Local Government Area.

Discussion of Findings

The findings presented in table 1 revealed that there was a low negative and statistically non-significant relationship between the availability of digital learning tools and students' academic performance in mathematics. Although digital learning tools are generally considered important components of contemporary mathematics instruction, the findings suggest that their mere

availability may not necessarily translate into improved academic outcomes within the study area. This outcome may be attributed to inadequate utilization, poor maintenance culture, unstable electricity supply, insufficient teacher competence in ICT integration, or limited student access to available facilities. The finding differs from the study by Salau (2021), who reported that access to digital learning technologies positively enhanced conceptual understanding, engagement, and performance in mathematics. The disparity may be due to contextual differences in infrastructural realities and levels of ICT implementation across Sagbama Local Government Area.

The findings presented in table 2 shows a moderate positive but statistically non-significant relationship between the utilization of interactive presentation systems and students' academic performance in mathematics. This indicates that although increased utilization of interactive presentation systems appears associated with improved mathematics performance, the relationship was not strong enough to attain statistical significance. The result suggests that the use of multimedia instructional technologies alone may not be sufficient to significantly influence academic achievement without complementary

instructional conditions such as teacher preparedness, curriculum alignment, and stable technological infrastructure. This finding partially contrasts with Onurgbo and Onurgbo (2023), who established significant gains in students' learning outcomes following exposure to interactive presentation media. The difference may stem from methodological variations, geographical conditions, and the practical limitations of ICT deployment within public secondary schools in Sagbama Local Government Area.

Conclusion

Although digital learning tools and interactive presentation systems are important components of modern instructional practice, their relationships with students' academic performance in mathematics in senior secondary schools in Sagbama Local Government Area were not statistically significant. The availability of digital learning tools demonstrated a low negative relationship with mathematics achievement, while the utilization of interactive

presentation systems showed a moderate positive relationship that did not reach statistical significance. These findings imply that ICT resources alone may not automatically improve students' academic performance unless accompanied by effective implementation strategies, teacher competence, adequate infrastructural support, and consistent pedagogical application.

Recommendations

The following recommendations are offered based on the study's findings:

1. Educational authorities and school administrators should provide digital learning tools and ensure their effective utilization, maintenance, and accessibility to teachers and students for meaningful instructional outcomes.
2. Government and educational stakeholders should improve supporting infrastructure such as electricity supply, internet access, and technical support services to enhance the functionality of ICT facilities in public secondary schools.

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